A STUDY TO EXAMINE THE CHANGES IN SCAPULAR POSITION BETWEEN ELITE AND RECREATIONAL SWIMMER"

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CERTIFICATE

The work embodied in the thesis entitled "**A Study To Examine The Changes In Scapular Position Between Elite And Recreational Swimmer"** submitted to The Tamilnadu Dr.MGR Medical University, Chennai in partial fulfillment for the degree of Master of Physiotherapy [Advanced PT in Sports Physiotherapy], was carried out by candidate bearing register number 27103015 at Cherraan's College of Physiotherapy, Coimbatore under my supervision. This is an original work done by him and has not been submitted in part or full or any other degree / diploma at this or any other university / institute. The thesis is fit to be considered for evaluation for award of the degree of Master of Physiotherapy.

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DECLARATION

The work embodied in the thesis entitled " **A Study To Examine The Changes In Scapular Position Between Elite And Recreational Swimmer"** submitted to The Tamilnadu Dr.MGR Medical University, Chennai in partial fulfillment for the degree of Master of Physiotherapy [Advanced PT in Sports Rehabilitation], was the original work carried out by me and has not been submitted in part or full for any other degree / diploma at this or any other university / institute. All the ideas and reference have been duly acknowledged.

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Mr. VIRAJ V. PANDIYA

ABSTRACT

Title:

Examine the change in scapula by measuring it in both elite and Recreational swimmer

Method and Measurement :

There are 50 elite and 50 Recreational swimmer has participated voluntarily for this study. By using KEIBLER I (45^0) and KEIBLER II (90^0) method the measurement has been taken to examine the difference between elite and recreational.

Result:

After measuring with KEIBLER I & II the data is collected and compared between each other where there is mean difference is ($P < 0.0001$) but there was no significant difference between Elite and Recreational when Keibler II method is used.

Conclusion:

After examination it is found that, the scapular positions changed in both types of Elite & Recreational Swimmer but there was no difference in Recreation and Elite Swimmers' measurements, when checked by Keibler II Method.

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INTRODUCTION

Swimming is a unique sport relying primarily on the muscles of the arm and shoulder to propel the body forward in the water.[1] Competitive swimmers usually train 10,000 - 20,000 yards / meters per day, using freestyle arm stroke for most of the distance.[2]

Swimming has a distinct profile of injuries and medical conditions.[2] The shoulder joint being the most vulnerable joint to injury.[3] Most of the injuries arise due to repetitive micro-trauma and over use, stemming from the faulty techniques executed during swimming.[2-4]

Important functions of the scapulae include the contribution to the glenohumeral stability, retracting and protracting the scapulae along thoracic wall, elevating the acromion, acting as a base for muscular attachment and aiding in proximal to distal transfer of energy and forces, which accounts for the optimal shoulder function.[5] These functions are in turn dependent upon the normal functioning of the scapular stabilizing muscles.[5,6.]

The causes for the shoulder pain previously taught to be anatomical now appear largely to be muscle weakness, dynamic muscle imbalance and biomechanical faults6 Weakness or dysfunction of scapular musculature alters the normal scapular positioning and mechanics where the scapula fails to perform its stabilization role and shoulder function becomes insufficient[6,7] in swimmers, this manifests as insufficient scapular protraction and lateral rotation during swimming stroke and increasing the tendency for a rotator cuff impingement.[8]

Alterations in the resting scapular position and dynamic scapular motion or scapular dyskinesis have been recognized to be frequently associated with many types of shoulder disorders, such as impingement, instability, and rotator cuff tear.[7,9,10]

It has been suggested that the lateral displacement of the scapula from the thoracic midline may serve as an indicator of the scapular stabilizer muscle weakness.[5]

Voight et al (1996) concluded that the fatigue due to repetitive exercise in PNF D2 patterns may induce an adverse effect on shoulder scapular positioning by allowing the scapula to glide more laterally during the functional activities." Carpenter et at (1998) found that the fatiguing exercises on shoulder reduce the joint proprioception, affecting shoulder function'2 and fatigue in the scapular muscles, causes secondary impingement.6"3 High intensity exercises are associated with the development of fatigue'4 and studies have shown fatigue to be associated with sports like swimming and soccer.[15,16]

Many studies have been done comparing the scapular rotation in swimmers with and without impingement, comparison between dominant and non - dominant and in impaired and unimpaired shoulders using modified digital inclinometer and isokinetic dynamometers etc.[17-21] The manual methods such as Kibler and Diveta scapular measurement techniques are also reliable in measuring the scapular position in swimmers. (Intraclass correlation coefficients (ICCs) for intratester reliability range from 0.92-0.95 - Diveta technique and 0.81- 0.94 - Kibler technique)[22]

These manual methods can be practically used at instant situations like adjacent to pool areas to analyze scapular dyskinesis and cost effective compared to other laboratory methods such as radiographs and EMG.[23]

A study conducted by Naula and Smith (2000) for the measurement of scapular position in swimmers recommended the use of Kibler 2nd and 3rd methods. They speculated that there are only a few scapular stabilizer muscles active in the Kibler- 1 position and greater activity of these muscles in the Kibler-2 and Kibler-3 positions. Therefore, Kibler-2 and Kibler-3 measurements may be more sensitive indicators of scapular fatigue as this assesses the scapular position in dynamic state rather than the Kibler -1 measurement that measures in static position.[2]

AIMS & OBJECTIVES

2.1 Aim:

To measure and compare, the differences between the scapular positions within and between Elite and Recreational Swimmers.

2.2 Significance of the Study:

After measuring the elite and recreational by keibler I & II method there is significant different between both type of swimmer. This study the help them to know scapular muscles is being very important for swimmers to propel their body in water without any scapular muscles dysfunction.

2.3 Objectives:

1. To examine and compare the measurements of the scapular positions in Recreational Swimmers by suing KEIBLER I (45^0) & KEIBLER II (90^0).
2. To examine and compare the measurements of the scapular positions in Elite Swimmers by using KEIBLER I (45^0) & KEIBLER II (90^0).
3. To compare the measurements of the scapular positions between Recreational an Elite Swimmers, when measured by both KEIBLER I (45^0) & KEIBLER II (90^0) methods.

2.4 Hypotheses:

Experimental hypothesis:

1. There will be significant difference in the measurements of the scapular positions in Recreational Swimmers, when measured by using KEIBLER I (45^0) & KEIBLER II (90^0) respectively.
2. There will be significant difference in the measurements of the scapular positions in Elite Swimmers, when measured by using KEIBLER I (45^0) & KEIBLER II (90^0) respectively.
3. There will be significant difference in the measurements of the scapular positions between Recreational and Elite Swimmers, when measured by using KEIBLER I (45^0) & KEIBLER II (90^0) respectively.

Null hypotheses:

1. There will be no significant difference in the measurements of the scapular positions in Recreational Swimmers, when measured by using both methods, KEIBLER I (45^0) & KEIBLER II (90^0) respectively.
2. There will be no significant difference in the measurements of the scapular positions in Elite Swimmers, when measured by using both methods KEIBLER I (45^0) & KEIBLER II (90^0) respectively.
3. There will be no significant difference in the measurements of the scapular positions between Recreational and Elite Swimmers, when measured by using both KEIBLER I (45^0) & KEIBLER II (90^0) methods, respectively.

REVIEW OF LITERATURE

A study to find out the glenohumeral rotation and scapular position adaptations after a single high school female sports season in thirty two female overhead athletes with no history of shoulder or elbow surgery and participating in high school swimming, volleyball, or tennis, using digital inclinometer. The results showed reduced internal rotation and scapular protraction and external rotation in swimmers from pre season to post season.[24] **Stephen John Thomas (2009)**

A systematic review stated that there is an evidence of scapular kinematic alterations associated with shoulder impingement, rotator cuff tendinopathy, rotator cuff tears, glenohumeral instability, adhesive capsulitis, and stiff shoulders. Evidence also showed altered muscle activation in the patient populations, particularly, reduced serratus anterior and increased upper trapezius activation and the scapular kinematic alterations.[7] **Paula M. Ludewig and Jonathan F. Reynolds (2009)**

A study to examine the effect of age and gender on physical performance in swimming by assessing one — hour swimming performance in healthy men and women. Results showed that the age related declines in performance were twice at 40 years and four times great at the age of 80 years than at 20 years of age.[25] **Vanina bongard et al. (2007)**

A study to determine the effects of shoulder muscle fatigue in twenty healthy subjects by administering a fatigue protocol and taking the three dimensional

scapulothoracic and glenohumeral kinematics by collecting the surface EMG data from upper and lower trapezius, serratus anterior, anterior and posterior deltoid and infraspinatus. Results showed more upward rotation and external

rotation of the scapula, more clavicular retraction and less humeral external rotation during arm elevation.[26] **David Ebaugh et al. (2006)**

A study on scapular rotation in 20 swimmers with impingement and 20 swimmers without impingement syndrome to examine the effects of a normal swim practice on the scapular kinematics pre swim to post swim. Results showed that both groups experienced muscle fatigue and decreases in scapular upward rotation in subjects with shoulder impingement when measured at 45, 90 and 135° of humeral elevation with inclinometer. They concluded that abnormal scapular kinematics in swimmers may be immediately examined after swimming and provide more information regarding impingement syndrome than a typical clinical exam.[20] **Ka P1k Eva Su et al. (2004)**

A Study concluded that the effects of intense swimming exercise on the scapular position in twenty male high school swimmers using the commonly accepted Kibler and Diveta scapular position measurement techniques and concluded that the don- dominant side scapulae moved more laterally post exercise and recommended further studies using the Kibler 2nd and 3rd scapular measurement methods.[22] **N. M. Naula Crotty and Jay Smith (2000)**

A study measured shoulder proprioception in twenty volunteers with no shoulder abnormalities by using the threshold to first detection of humeral rotation with joint at 90 degrees of abduction and 90 degrees of external rotation as the measurement of shoulder proprioception to test the effect of fatigue on shoulder joint position sense. Results showed a decrease in proprioceptive sense with muscle fatigue in athletes.[12] **James E.Carpenter et al. (1998)**

The study examined the intra tester and inter tester reliability of two classic methods (Kibler and Diveta) on a convenient sample of seventeen subjects without postural abnormalities, shoulder pathology or surgery. Results showed moderate to good intra tester reliability (ICC 0.96 - 0.80 for both methods) and inter tester reliability (ICC 0.42 to 0.90) with higher values, moderate to good for the Kibler technique.[27] **Leen T' jonck et al. (1996)**

A study on thirty two volunteered subjects to find out the Reliability of measurement techniques (Kibler and Diveta) used to determine static scapular position. Results showed intra tester reliability of 0.81-0.94 for Kibler method and 0.92 - 0.95 for Diveta method.[23] **Mark H. Gibson et al. (1995)**

A study to investigate the validity of heart rate and ratings of perceived exertion as indices of exercise intensity in a group of six healthy male swimmers in swimming. Results showed high linear correlation with r = 0.962 - 0.996 for relationship between heart rate and vo2 and r = 0.962 - 0.996 for relationship between heart rate and

percentage maximal oxygen consumption. They concluded that heart rate was valid as an index of the exercise intensity while swimming.[28] **Kurokawa T and Veda T (1992)**

The study described the patterns of activity of twelve muscles of the shoulder during freestyle swimming in normal shoulders using the EMO and cinematographic analysis. Results showed that three heads of the deltoid and the supraspinatus function in synchrony to place the arm at hand entry and exit, the rhomboids and upper trapezius position the scapula for the arm, the pectoralis major and latissimus dorsi propel the body, the subscapularis and serratus anterior muscles are constantly active, the teres minor functions with the pectoralis major, and the infraspinatus is active only to externally rotate the arm at midrecovery. They concluded that the shoulder stabilizing muscles are active in swimming.[29] **Marilyn et al. (1991)**

MATERIALS AND METHODOLOGY

4.1 Source of data:

Competitive Swimmers, who have been swimming for past 5 years, were requested to participate in the study and they signed informed Consent form, stating voluntary participation.

4.2 Site of collection of data:

Participants belong to ,

1. Otters club. Cartter road, Bandra(West).
2. Prabothan Thakrey Sports Club(Andheri).

4.3 Sample size:

50 Elite and 50 Recreational Swimmers participated in study.

4.4 Sampling:

Purposive sampling.

4.5.Measurement procedure :

After the selection of subjects fulfilling the inclusion and exclusion criteria, physical examination will be done to assess for the evidence of scoliosis, congenital defect of scapula, scapular winging and neuromusciular disorder affecting the shoulder function.

Pre participation data will be collected including age, hand dominance, hand span, arm span, weight, height, BMI, number of years in competitive swimming, average time in swimming training/day, best swimming experience, number of competitions participated, competitive swimming results, training programme / group, stroke used frequently, medical or

supplements information, weekly training morning and evening schedules and injury profile. Consent will be obtained from the participants prior to the study.

Prior to the warm up measurement of scapular position using the Kibler 2nd and 3rd method will be taken and heart rate will be recorded manually by taking the radial pulse over the radial styloid process of the left hand for 1 minute. Heart rate will be used as an intensity monitoring for the particular exercise training session.

Swimmers who have got Vo2 max equal to or higher than 70%, their data will be taken for the scapular position examination. Prior to the training heart rate and scapular position measurements using Kibler 2nd and 3rd method will be taken. Subjects will be then asked to proceed for their training and during the training heart rate will be recorded. Immediately after the training, the scapular position measurement using the Kibler 2 nd and 3rd method will be taken along with the heart rate. The subjects will be then instructed to remain in the pooi for the warm down and the scapular position measurements and heart rate will be taken after the warm down.

KIBLER MEASUREMENT METHODS :

1. KIBLER I METHOD OF SCAPULAR MEASUREMENT

Inferior angle of the scapula and spinous process adjacent to the inferior angle will be palpated, with the subject standing by placing his arms on hips (45 degrees of abduction).

2. KIBLER II METHOD OF SCAPULAR MEASUREMENT

Inferior angle of the scapula and spinous process adjacent to the inferior angle will be palpated with the subject standing by placing his arm at 90 degrees of abduction and internally rotated in the plane of the scapula.

In both the positions, the inferior angle and the spinous process adjacent to the inferior angle will be marked with an indelible ink marker and adhesive tags will be placed with point of arrow placed on midpoint of the mark over the inferior angle of scapula and spine opposite to the inferior angle. Measurement will be taken by a 12 inch length of 1 cm wide inelastic white fabric.

Length of fabrics will be clearly labeled with subject's name, side being measured and the Kibler method used. After completion strips will be placed in the bag and the distance between the markings will be measured at a later date by placing the fabric against the 18 inch ruler. A side to side difference of greater than or equal to 1.5cm will be taken as clinically significant.[22]

4.6. Materials to be used :

- lndelible ink marker
- Adhesive tag showing arrow
- 12 inch length of 1 cm wide inelastic white fabric
- 18 inch ruler
- Pen
- Paper
- Stopwatch
- Inch tape
- Table
- Chair

4. 7 Inclusion Criteria:

- Males aged 18- 30 years.
- No history of pain around shoulder and neck for 3 months before the study.
- No history of surgery around shoulder and Neck.
- Swimming since past 5 years.

4.8. Exclusion Criteria:

- History of pain around Shoulder, neck and Rib cage.
- History of surgery around shoulder, neck and rib cage.
- History of trauma and/or injury.

4.9. Ethical Clearance:

Does the study require any investigations or interventions to be conducted on patients or other humans or animals? If so please describe briefly.

YES. This study involves the physical examination on the athletes. Consent has been taken from Institute's Ethical clearance committee.

STATISTICAL ANALYSIS

STUDY DESIGN: Cross Sectional Study Design

STATISTICAL TEST:

For paired samples

1. related t-test

For independent observations

1. Independent t-test ,
2. Levene’s test for equality of variance.

Table 1 .Recreational 45^0 & Recreational 90^0 Shoulder Abduction

	Mean ± standard deviation	Paid 't' value	Significance
Recreational 45^0	10.58 ± 0.68	3.876	p <0.0001
Recreational 90^0	13.4 ± 5.1		

RESULT

The comparison of Recreational swimmer in 45^0 & 90^0 having mean difference is p <0.0001

Table 2 .Elite 45^0 & Elite 90^0 Shoulder Abduction

	Mean ± standard deviation	Paid 't' value	Significance
Elite 45^0	11.6 ± 1.05	9.072	p <0.0001
Elite 90^0	13.08 ± 1.06		

RESULT

The comparison of Elite swimmer in 45^0 & 90^0 having mean difference is p <0.0001

Table 3. Recreational 45^0 & Elite 45^0 Shoulder Abduction

	Mean ± standard deviation	Paid 't' value	Significance
Recreational 45^0	10.59 ± 0.68	5.827	p <0.0001
Elite 45^0	11.63 ± 1.05		

RESULT

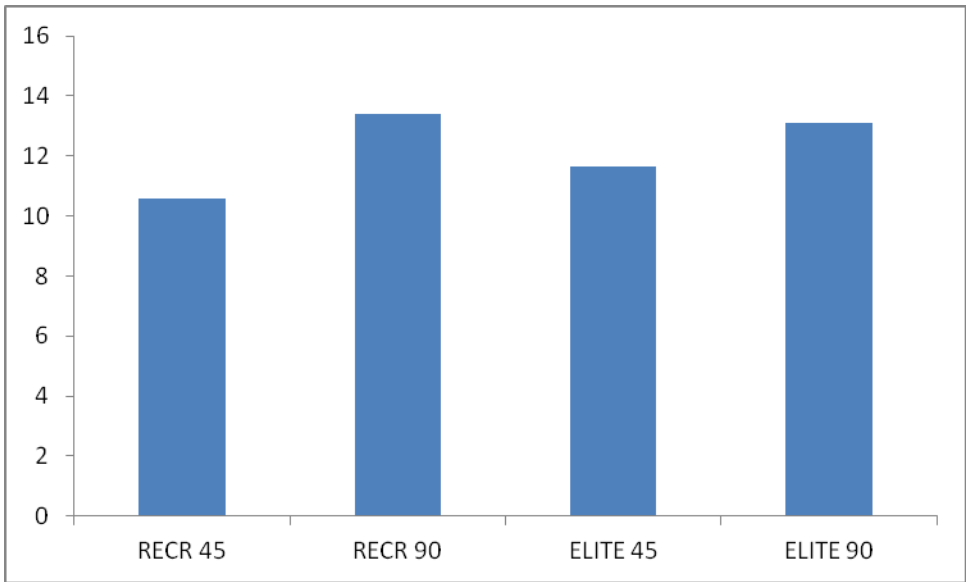
The comparison of Elite & Recreational swimmer in 45^0 having mean difference is p <0.0001

Table 4 .Recreational 90^0 & Elite 90^0 Shoulder Abduction

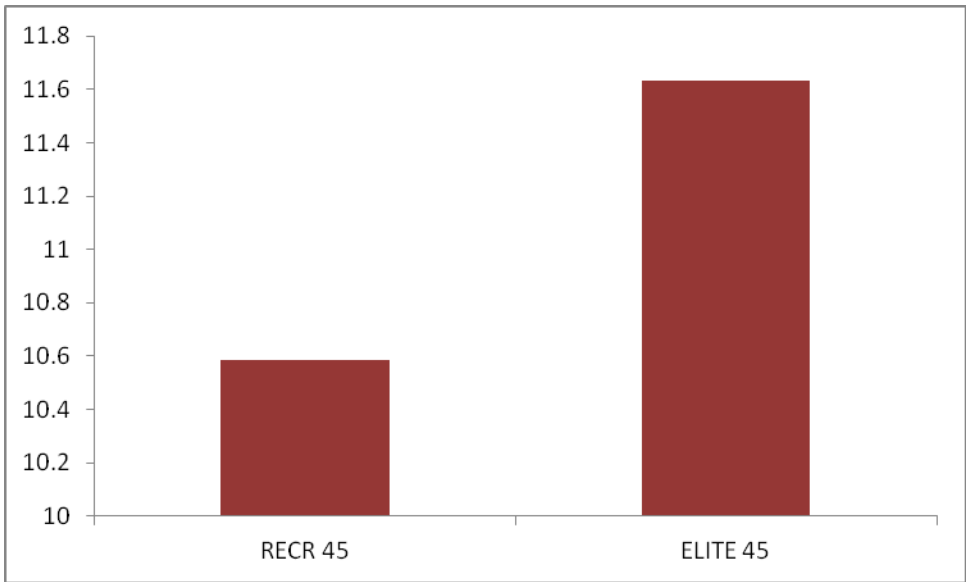
	Mean ± standard deviation	Paid 't' value	Significance
Recreational 90^0	13.42 ± 5.1	0.457	p <0.649
Elite 90^0	13.08 ± 1.06		

RESULT

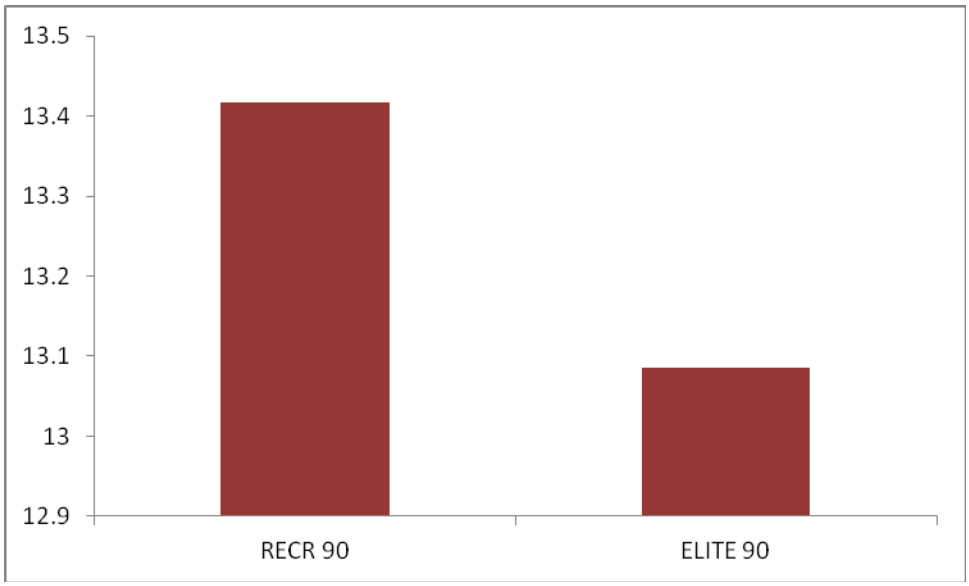
The comparison of Recreational swimmer and elite swimmer in 45^0 & 90^0 having mean difference is p <0.649



GRAPH 1 - COMPARISON OF SCAPULAR MEASUREMENT OF RECREASIONAL AND ELITE SWIMMER



GRAPH 2 - COMPARISON BETWEEN RECREASONAL AND ELITE SWIMMER IN 45^{O} WITH (P<0.001) DIFFERENCE



GRAPH 3 - COMPARISON BETWEEN RECREASONAL AND ELITE SWIMMER IN 90^{O} WITH (P<0.649) DIFFERENCE

DISCUSSION

Normal shoulder biomechanical function requires an intact kinetic chain and various scapular muscles to create the energy and produce the forces to cause movement around the shoulder joint and to stabilize the joint.[19]

Normal scapular function is a pre-requisite for the normal movement of the upper extremity, where the scapular function in turn is dependent upon the normal functioning of the scapular stabilizing muscles which include the upper and lower trapezius, rhomboids and serratus anterior muscles.[19]

It was reported that weakness of the scapular stabilizer muscles will lead to the lateral displacement of the scapula over the thoracic rib cage.

Kibler (1998) proposed the Kibler 1st, 2nd and 3rd position of scapular position measurement techniques to assess the scapular position in overhead athletes where the Kibler 2nd and Kibler 3rd position had more muscular activity and are taught to be more dynamic in nature when compared with the Kibler 1st position.

Naula and Smith (2000) used the Kibler 1st position to examine the changes in the scapular position and did not find any significant result (p=0.28). They suggested the use of Kibler 2nd and Kibler 3rd position to examine the scapular position as they proposed these methods of scapular position measurements to be more dynamic in nature when compared to Kibler 1st position.

There are no studies reported till now according out knowledge which have used the Kibler 1st and Kibler 2nd positions simultaneously in single study to measure the scapular displacement from the thoracic midline .

Hence, the present study was conducted to examine and compare the measurements of the scapula postions in Recreational and Elite swimmers. We used two positions Kibler 1st and Kibler 2nd positions to measure the linear distance between the inferior angle of the scapula and the adjacent spinous process.

By using both the method on both the group verification is done to examine the changes in scapular position. Where comparison between recreation 45^0& Recreation 90^0 ($p < 0.0001$) and elite 45^0 and Elite 90^0 ($p < 0.0001$) and Elite 45^0 ($p < 0.0001$) and Recreational 45^0 ($p < 0.0001$) and Recreational 90^0 and Elite 90^0 no difference is observed

Scapular displacement measurement by Kibler II position

The results of the independent t-test performed to assess the linear change in scapular position between Recreational and Elite Swimmers, showed no statistically significant result for the Kibler 2nd position on right side($p = 0.649$).

The deviation of the scapula from thoracic midline in Kibler II position is thought to be due to fatigue of serratus anterior and lower trapezius, which are the only two muscles working to stabilize the scapula in Kibler II position.[17] The electro- myographic findings have shown that

that Serratus anterior and Trapezius muscles are more prone to undergo fatigue than other muscles about the shoulder during the repetitive overhead motions such as swimming and throwing.

This might be the reason for the muscles to displace the scapula laterally as a result of muscle fatigue leading to muscle imbalance.

It has also been suggested that the testing of serratus anterior muscle function should be done with hands below the level of horizontal plane(shoulder level) as this will place the muscle at mechanical disadvantage and is therefore a more sensitive measure to detect even a small degree of weakness in the muscle.

Kibler II position what we used also places the hands below the horizontal plane, where the arms were placed on the hips (45 degrees of humeral abduction) which places the serratus anterior muscle at mechanical disadvantage and a more sensitive position to detect even the minute changes occurring in the muscle due to fatigue. This might explain the cause for abnormal lateral deviation of the scapula from thoracic midline as a result of training induced fatigue of serratus anterior.

An EMG analysis of the shoulder muscles during swimming by marylin et al. (1991) showed that the serratus anterior and subscapularis were the only two muscles which were constantly active throughout the swimming[21] since the serratus anterior and lower trapezius are the only two muscles which are functioning in Kibler II position, any fatigue in these muscles

throughout the swimming might cause the abnormal lateral displacement of the scapula.This might be reason for not getting significant difference with Keibler II method.

Also, data was collected only on the right side shoulders of all the participants, which might be the cause of underestimation of results with Kiblers II method. The tone and flexibility of muscles, determines the positions of bones and joints it is attached to with. Also, as the dominance of the upper limb plays major role in the tone and flexibility of the muscles, which are being used repeatedly for specific activity, the muscle of shoulder girdle and dynamic

scapula stabilizers must have altered in regard of muscle tone and flexibility in case of Recreational and Elite swimmers. But, due to inconvenience of getting appointments from busy schedules of participants and lack of availability of standard study setting and issues of privacy, investigator forced to take all measurements only on the right shoulders of all participants. This lead to incomplete measurement and comparison scapula positions, as all participants were not Right hand dominant, and their left shoulder measurements might have shown the significance with kibler II method.

There is good scope for future researcher to, examine the positions of scapula on the both shoulders and compare measurements. Further, comparisons between measurements of right and left side of shoulders of each Swimmer can also throw light on the effect of upper imb dominance on the scapula positions from midline, tone and flexibility of shoulder girdle dynamic stabilizers, which will be useful for avoiding injury of shoulder in competitive swimmers, by taking precautions for avoiding and correcting shoulder girdle muscle imbalance and Upper cross syndrome in future.

LIMITATIONS

- Recreational swimmer and elite swimmer when measurement has taken ,only scapular measurement has taken but its not taken on based of whether they are in dry land exercise or not.

- In study only swimmer is in consideration but not the gender.

- Along with swimmers are vary in body mass index which is not in consideration.

CONCLUSION

After examine the scapular position changed in both type of elite & recreational swimmer but there was no difference in recreation and elite when checked by Keibler II Method.

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APPENDICES

APPENDIX – I

CONSENT FORM

I have been informed about the procedures and the purpose of the study. I have understood that I have the right to refuse my consent or withdraw it any time during the study without adversely affecting my treatment. I am aware that being subjected to this study I will have to give my more time for assessments and treatment and these assessments do not interfere with the benefits.

I, _____, the under signed, give my consent to be a

Participant of this investigations/study program/clinical trial.

Signature of the investigator

Date:

Signature of subject

(Name and address)

APPENDIX II

50 RECREATIONAL SWIMMER SCAPULAR MEASURMENT

All Measurement in Cm.

S.No	KEIBLER 1 (45)			
1	10	10.2	10	10.06666667
2	11	11	11	11
3	9	9.5	9.6	9.366666667
4	10	10.3	10.3	10.2
5	12	12	12	12
6	11	11	11	11
7	11.1	11.1	11.2	11.13333333
8	10	10	10	10
9	10.2	10.2	10	10.13333333
10	13	13	13	13
11	11	11	11	11
12	11	11	11	11
13	11.2	11.3	11.2	11.23333333
14	9	9.8	9.9	9.566666667
15	11	11	11	11
16	10	10	10	10
17	10	10	10.2	10.06666667
18	9	9.1	9.3	9.133333333
19	11	11.4	11.3	11.23333333
20	10	10	10	10
21	11	11.1	11.2	11.1
22	10	10.2	10.2	10.13333333
23	10	10.3	10.4	10.23333333
24	11	11	11.1	11.03333333
25	11	11	11	11
26	10	10.1	10.1	10.06666667
27	11	11	11	11
28	11	11.1	11.2	11.1
29	10	10.2	10.2	10.13333333
30	10	10.1	10.2	10.1
31	10	10	10	10
32	12	12.1	12.1	12.06666667
33	10	10.1	10.1	10.06666667

34	11	11.2	11.3	11.16666667
35	10.8	10.8	10.8	10.8
36	10	10.1	10.1	10.06666667
37	10.9	10.9	10.9	10.9
38	10.5	10.5	10.5	10.5
39	10.1	10.1	10.2	10.13333333
40	10.6	10.6	10.6	10.6
41	10.2	10.2	10.2	10.2
42	10.3	10.3	10.4	10.33333333
43	10.4	10.2	10.4	10.33333333
44	10.3	10.3	10.3	10.3
45	10.4	10.5	10.4	10.43333333
46	10.6	10.7	10.6	10.63333333
47	10.5	10.5	10.5	10.5
48	10.8	10.8	10.8	10.8
49	10.8	10.9	10.8	10.83333333
50	10.7	10.4	10.5	10.53333333

50 RECREATIONAL SWIMMER SCAPULAR MEASURMENT

All Measurement in Cm.

S.No	KEIBLER 2 (90)			
1	11.5	11.6	11.5	11.53333333
2	12.8	12.7	12.8	12.76666667
3	11.7	11.6	11.7	11.66666667
4	11.2	11.1	11.2	11.16666667
5	14.3	14.3	14.3	14.3
6	13.1	13.1	13.1	13.1
7	13.2	13.2	13.2	13.2
8	12.1	12.1	12.2	12.13333333
9	12.2	12.2	12.2	12.2
10	14.1	14.1	14.3	14.16666667
11	13.1	13.1	13.1	13.1
12	13.4	13.4	13.4	13.4
13	13.4	13.4	13.4	13.4
14	12.9	12.9	12.9	12.9
15	13.3	13.3	13.3	13.3
16	13.4	13.4	13.4	13.4
17	13.5	13.6	13.5	13.53333333
18	11.2	11.1	11.2	11.16666667
19	13.1	13.2	13.1	13.13333333
20	11.7	11.7	11.7	11.7
21	13	13.1	13.1	13.06666667
22	13.3	13.3	13.4	13.33333333
23	13	13	13	13
24	12.1	12.1	12.1	12.1
25	13	13	13	13
26	12.5	12.5	12.6	12.53333333
27	13	13	13	13
28	12.2	12.2	12	12.13333333
29	13	13.1	13	13.03333333
30	121	12.1	12.1	48.4
31	12	12	12	12
32	14.2	14.3	14.2	14.23333333
33	12.2	12.2	12.2	12.2
34	13.3	13.3	13.3	13.3
35	13	13.1	13	13.03333333
36	12.4	12.5	12.4	12.43333333

37	11.7	11.7	11.7	11.7
38	12.9	12.9	12.9	12.9
39	13.1	13.1	13.1	13.1
40	13.1	13.1	13.2	13.13333333
41	12.2	12.2	12.2	12.2
42	12.5	12.5	12.5	12.5
43	14.1	14.1	14.1	14.1
44	13.1	13.1	13.1	13.1
45	12.3	12.3	12.3	12.3
46	12	12	12	12
47	12.1	12.1	12.1	12.1
48	11	11	11.1	11.03333333
49	11.6	11.6	11.6	11.6
50	13	13	13.1	13.03333333

50 ELITE SWIMMER PLAYER SCAPULAR MEASURMENT

All Measurement in Cm.

S.No	KEIBLER 1 (45)			
1	11	11	11	11
2	11	11	11	11
3	12.2	12.2	12.3	12.23333333
4	11	11	11.3	11.1
5	12	12.1	12.1	12.06666667
6	12	12.1	12.1	12.06666667
7	13	13.1	13	13.03333333
8	13	13	13	13
9	12	12	12	12
10	12	12	12	12
11	16	16	16	16
12	10	10	10	10
13	10.2	10.2	10.2	10.2
14	11.8	11.8	11.9	11.83333333
15	12	12.1	12.1	12.06666667
16	13.1	13	13	13.03333333
17	11	11	11	11
18	11	11.1	11.1	11.06666667
19	11.2	11.2	11.1	11.16666667
20	11.3	11.2	11.1	11.2
21	11.4	11.4	11.4	11.4
22	10.1	10.1	10.1	10.1
23	9	9	9	9
24	12	12	12	12
25	13	13	13	13
26	11	11	11	11
27	10	10.8	10.2	10.33333333
28	11.1	11	11.1	11.06666667
29	12	12	12	12
30	12	12.3	12.3	12.2
31	11.1	11.1	11.1	11.1
32	12.4	12.4	12.4	12.4
33	11.1	11.1	11.1	11.1
34	11	11	11	11
35	11.6	11.6	11.6	11.6

36	11	11	11	11
37	11.3	11.3	11.3	11.3
38	12.4	12.4	12.4	12.4
39	11	11	11	11
40	11.2	11.2	11.2	11.2
41	12	12	12	12
42	12.1	12.1	12.1	12.1
43	11.1	11	11.1	11.06666667
44	12.1	12.1	12.1	12.1
45	11.3	11.3	11.3	11.3
46	11.7	11.7	11.7	11.7
47	12.9	12.9	12.9	12.9
48	12.1	12.1	12.1	12.1
49	12.2	12.2	12.2	12.2
50	11	11	11	11

50 ELITE SWIMMER PLAYER SCAPULAR MEASURMENT

All Measurement in Cm.

S.No	KEIBLER 1 (45)			
1	11	11	11	11
2	11	11	11	11
3	12.2	12.2	12.3	12.23333333
4	11	11	11.3	11.1
5	12	12.1	12.1	12.06666667
6	12	12.1	12.1	12.06666667
7	13	13.1	13	13.03333333
8	13	13	13	13
9	12	12	12	12
10	12	12	12	12
11	16	16	16	16
12	10	10	10	10
13	10.2	10.2	10.2	10.2
14	11.8	11.8	11.9	11.83333333
15	12	12.1	12.1	12.06666667
16	13.1	13	13	13.03333333
17	11	11	11	11
18	11	11.1	11.1	11.06666667
19	11.2	11.2	11.1	11.16666667
20	11.3	11.2	11.1	11.2
21	11.4	11.4	11.4	11.4
22	10.1	10.1	10.1	10.1
23	9	9	9	9
24	12	12	12	12
25	13	13	13	13
26	11	11	11	11
27	10	10.8	10.2	10.33333333
28	11.1	11	11.1	11.06666667
29	12	12	12	12
30	12	12.3	12.3	12.2
31	11.1	11.1	11.1	11.1
32	12.4	12.4	12.4	12.4
33	11.1	11.1	11.1	11.1
34	11	11	11	11
35	11.6	11.6	11.6	11.6

36	11	11	11	11
37	11.3	11.3	11.3	11.3
38	12.4	12.4	12.4	12.4
39	11	11	11	11
40	11.2	11.2	11.2	11.2
41	12	12	12	12
42	12.1	12.1	12.1	12.1
43	11.1	11	11.1	11.06666667
44	12.1	12.1	12.1	12.1
45	11.3	11.3	11.3	11.3
46	11.7	11.7	11.7	11.7
47	12.9	12.9	12.9	12.9
48	12.1	12.1	12.1	12.1
49	12.2	12.2	12.2	12.2
50	11	11	11	11

50 ELITE SWIMMER PLAYER SCAPULAR MEASURMENT

All Measurement in Cm.

S.No	KEIBLER 2 (90)			
1	13	13	13.1	13.03333333
2	13.1	13.1	13.1	13.1
3	13	13	13	13
4	14	14	14	14
5	13	13	13.1	13.03333333
6	13	13	13	13
7	14	14	14	14
8	14.1	14.1	14.1	14.1
9	13	13	13	13
10	13	13	13	13
11	11.2	11.2	11.2	11.2
12	11.2	11.2	11.2	11.2
13	12.2	12.2	12.2	12.2
14	13.1	13.1	13.1	13.1
15	13.2	13.2	13.2	13.2
16	15.2	15.2	15.2	15.2
17	12	12.1	12.1	12.06666667
18	12	12	12	12
19	12.8	12.8	12.8	12.8
20	13	13	13	13
21	13	13	13	13
22	12.5	12.5	12.5	12.5
23	11	11	11	11
24	13.3	13.3	13.3	13.3
25	15.6	15.6	15.6	15.6
26	12.2	12.2	12.2	12.2
27	12.2	12.2	12.2	12.2
28	12	12	12	12
29	13.3	13.3	13.3	13.3
30	13	13	13	13
31	13	13.1	13	13.03333333
32	14	14	14	14
33	12.2	12.2	12.2	12.2
34	12	12	12	12
35	12	12.1	12.1	12.06666667

36	12	12	12	12
37	12	12.1	12.1	12.06666667
38	14.5	14.5	14.5	14.5
39	12	12	12	12
40	12.2	12.3	12.1	12.2
41	14	14	14	14
42	14	14.1	14.1	14.06666667
43	15	15.1	15	15.03333333
44	14.2	14.2	14.2	14.2
45	14.3	14.1	14.2	14.2
46	13	13.1	13.1	13.06666667
47	15	15.1	15	15.03333333
48	14.1	14.2	14.1	14.13333333
49	14	14	14	14
50	13.2	13.1	13	13.1

T-TEST

Paired samples Statistics

	Mean	N	Standard Deviation	Standard Error Mean
Pair 1 RECR 45	10.5847	50	0.68158	0.09639
RECR 90	13.4173	50	5.11035	0.72271
Pair 2 ELITE 45	11.6347	50	1.050	0.14851
ELITE 90	13.0847	50	1.060	0.14998

Paired Samples Correlation

	N	Correlation	Significance
Pair 1 REC 45 & REC90	50	-0.019	0.897
Pair 2 ELITE 45 & ELITE 90	50	0.427	0.002

Paired Samples test

	Paired differenceses		
	Mean	Standard Deviation	Standard Error Mean
Pair 1 REC 45 & REC 90	-2.832	5.168	0.730
Pair 2 ELITE 45 & ELITE 90	-1.4500	1.13	0.159

Paired Samples test

	Paired difference				
	95% Confidence interval of the difference				
	Lower	Upper	t	df	Sig(2 ta
Pair 1 REC45 REC90	-4.30146	-1.36388	-3.876	49	0.0001
Pair 2 ELITE 45 ELITE 90	-1.77120	-1.12880	-9.072	49	0.0001

T-TEST

Group Statistics

	VAR00003	N	Mean	Std.Deviation	Std.error Mean
REC VS ELITE 45	1.00	49	10.59	0.54689	0.097
	2.00	50	11.63	1.050	0.1485
REC VS ELITE 90	1.00	49	13.42	5.163	0.737
	2.00	50	13.084	1.060	0.1499

Independent Sample Test

		Lavenen's test of equality of variances		't' test equality of mean	
		f	sig	t	diff
REC VS ELITE 45	Equal Variance Assumed	4.094	0.046	-5.827	97
	Equal variance not Assumed			-5.851	84.55
REC VS ELITE 90	Equal variance Assumed	1.121	0.292	0.457	97
	Equal variance not assumed			0.452	51.96

Independent Sample test

		t test of equality of mean		
		Sig (2-tailed)	Mean difference	Std error difference
REC VS ELITE 45	Equal Variance Assumed	0.000	-1.040	0.1786
	Equal variance not Assumed	0.000	-1.040	0.17789
REC VS ELITE 90	Equal variance Assumed	0.649	0.340	0.745
	Equal variance not assumed	0.653	0.340	0.752

Descriptives

	N	Minimum	Maximum	Mean	Std Deviation
REC 45	50	9.13	13.00	10.58	0.68
REC 90	50	11.03	48.40	13.41	5.11
ELITE 45	50	9.00	16.00	11.63	
ELITE 90	50	11.00	15.60	13.08	
Valid N (List Vise)	50				

CALCULATION CHART

NAME:_____

AGE:_____SEX:_____HEIGHT:_____WEIGHT:_

ADDRESS:_____
_____

YEAR OF SWIMMING (NOT<5YR,NOT >10 YR):_____

LEVEL OF
PARTICIPATION:_____

	1	2	3
KEIBLER 1			
KEIBLER 2			